Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Grande Ronde Basin Spring Chinook Captive Broodstock Program

Bonneville project number, if an ongoing project 9801001

Business name of agency, institution or organization requesting funding
Oregon Department of Fish and Wildlife/Nez Perce Tribe

Business acronym (if appropriate) ODFW/NPT

Proposal contact person or principal investigator:

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Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

NPPC Program Measure Number(s) which this project addresses.
6.2 Production, 6.26.2 Other Production Measures

NMFS Biological Opinion Number(s) which this project addresses.
The biological opinion for Hatchery Actions (page 67, Section 10.B.3 and 4) states “USFWS should terminate use of Rapid River stock at Lookingglass Hatchery no later than 1996” and “The USFWS should consider development of indigenous broodstock ...”

Other planning document references.
Captive broodstock programs for Snake River spring/summer chinook salmon are supported by Snake River Recovery Team recommendations (SRSR, 1994), NMFS

(1995a) draft recovery plan, and Wy-Kan-Ush-Me Wa-Kush-Wit Plan (Volume II page 116).

Subbasin.
Grande Ronde River

Short description.
Develop and implement captive broodstock programs and associated monitoring, evaluation and fish health for spring chinook salmon populations in Catherine Creek, and the upper Grande Ronde and Lostine rivers.

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction		Watershed
	Resident fish	*	O & M		Biodiversity/genetics
	Wildlife	*	Production		Population dynamics
	Oceans/estuaries	*	Research		Ecosystems
	Climate	*	Monitoring/eval.		Flow/survival
	Other	X	Resource mgmt	*	Fish disease
			Planning/admin.	X	Supplementation
			Enforcement		Wildlife habitat en-hancement/restoration
			Acquisitions		

Other keywords.
Captive broodstock, spring chinook salmon, hatchery effectiveness, conservation hatchery

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship
9202604	Early life history of spring chinook salmon in the Grande Ronde Basin.	We utilize migration timing information from this project to determine when to collect juveniles for captive broodstock. Life history information will also be used to access the success of supplementation programs
8805301	NE Oregon Hatcheries - ODFW, CTUIR, and NPT	Captive broodstock program will be directly integrated into the NE Oregon Hatcheries program as it will be providing the broodstock and eggs that will be utilized for NEOH.
8905302	NE Oregon Hatcheries - ODFW,	Captive broodstock program will be

	CTUIR, and NPT	directly integrated into the NE Oregon Hatcheries program as it will be providing the broodstock and eggs that will be utilized for NEOH.
5520700	Captive Broodstock Artificial Propagation	This is the NPT funding for cooperative evaluation of the Grande Ronde Spring Chinook Captive Broodstock Program.
8909600	Genetic Monitoring and Evaluation of Snake River Salmon and Steelhead	This project provides samples for the genetics monitoring program.
	Fish Passage Center Smolt Monitoring Program - Migration characteristics	During the summer we PIT tag parr in Catherine Cr & the Lostine and Grande Ronde Rivers. We collect parr for captive broodstock when parr PIT tagging occurs. This project also provides personnel and information to improve efficiencies.

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Assess maturation and characterize length, weight, and survival of all three stocks at Manchester Marine Laboratory and at Bonneville Fish Hatchery	a	Examine 1994,95,96 and 97 brood fish for maturation at BOH and MML. During the process of examining individuals for maturity and at other sample times we will inventory each stock & collect lengths & weights from a subsample to assess growth & condition.
2	Monitor the growth, development, and survival of the fish at Lookingglass Fish Hatchery	a	Measure the length and weight of a sample of fish from each stock on a monthly basis, until March, when final smolt development should begin

3	Mark all 1997 individuals in all three stocks with a secondary mark	a	Apply VI tags as a secondary mark to all individuals in each stock. The VI tags will porovide a backup identification to the PIT tags to ensure that individuals can be identified.
4	Determine when fish are ready to be transferred to seawater.	a	Rear a surrogate stock as similarly as possible to our seawater/natural growth fish. Fish will then be used in salinity tolerance tests.l
5	Collect 1998 brood juveniles from Catherine Creek, Lostine River, and upper Grande Ronde River populations.	a	Collect 500 parr in August and September thrughout the rearing area from each populaiton.
6	Provide samples for genetic analysis from 1996 and 1997 mortalities from Catherine Creek, Lostine River, and upper Grande Ronde River populations.	a	Mortalities suitable for genetics analysis will be provided to Dr. Robin Waples, NMFS, to be analyzed as part of the Snake River basin chinook salmon genetics monitoring program.
7	Coordinate ESA permit activities and participate in captive broodstock planning and oversight.	a	Continue leadership of the Grande Ronde Captive Broodstock Technical Oversight Team and participate in the Chinook Technical Oversight Committee.
8	Develop and implement complex matrix spawning protocols.	a	Assist fish propagation personnel in the development of the most appropriate spawning protocols. Sample fish as they are spawned.
9	Develop and maintain a database on the captive fish	a	Maintain a database for each individual fish. This database will include PIT and VI tag identification numbers, growth information, information on maturation, and survival.
10	Insure that an Annual Operations Plan is developed for the Captive Broodstock Program.	a	Coordinate and oversee the development and implementation of the Annual Operations Plan for the captive broodstock program.
11	Analyse and summarize data and prepare and submit an annual report	a	Write and submit an annual report covering the period of October 1, 1998 - September 30, 1999. We will also provide a written report

			to NMFS on our annual operations.
12	Determine etiology of captive broodstock morbidity and mortality.	a	Conduct diagnostic examinations using appropriate methods to identify infectious and disease causing agents.
		b	Make observations to attempt to identify any other causes of morbidity and mortality.
		c	Complete and distribute diagnostic reports.
13	Implement prophylactic erythromycin treatments for bacterial kidney disease under Investigational New Animal Drug (INAD) protocols.	a	Prepare annual protocols and submit to the INAD primary investigator.
		b	Coordinate protocols with hatchery personnel.
		c	Complete submission of annual protocols with Efficacy of Treatment forms to the primary investigator.
14	Implement therapeutic treatments as described in the Section 10 permit.	a	Prepare INAD protocols when required.
		b	Evaluate therapy through completion of Efficacy of Treatment forms
15	Monitor fish culture practices and fish handling for situations that may contribute to impaired fish health or exacerbate disease.	a	Maintain liaison with hatchery personnel and others handling the fish to obtain information.
		b	Recommend changes to procedures that may contribute to impaired fish health or exacerbate disease.
		c	Prepare a table of findings from diagnostic examinations
		d	Identify disease treatments required.
		e	Identify any recommended changes to fish culture operations.

16	Rear 1997 broodyear parr until they reach smoltification at Lookingglass Hatchery.	a	Provide all facilities,feed and personnel to rear 1997 brood until smoltification.
		b	Provide an adequate quantity and quality of water, and chilling facilities adequate to meet program requirements.
17	Safely transport 1997 brood fish to BOH and MML following smoltification.	a	Move 1997 brood fish from LGH to BOH and MML following smoltification at LGH.
18	Rear all 1994, 1995, 1996, and 1997 fish at Bonneville Fish Hatchery.	a	Provide all facilities,feed and personnel to rear all adult 1994, 1995, 1996 and 1997 brood until they are ready to spawn.
19	Oversee and facilitate the spawning of all ripe 1994, 1995, 1996 and 1997 fish.	a	Provide all facilities and personnel to spawn all 1994, 1995, 1996 and 1997 brood.
		b	Provide all facilities and personnel to collect, cryopreserve and store all semen from spawned males from 1994, 1995, 1996 and 1997 brood.
20	Receive 1998 brood after collection and rearing at Lookingglass Hatchery.	a	Provide all facilities, feed and personnel to rear 1998 brood

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	10/1998	9/1999	3.00%
2	10/1998	9/1999	2.00%
3	10/1998	11/1998	2.00%
4	3/1999	6/1999	2.00%
5	8/1999	10/1999	9.00%
6	10/1998	9/1999	1.00%
7	10/1998	9/1999	3.00%
8	10/1998	9/1999	2.00%
9	10/1998	9/1999	5.00%
10	12/1998	3/1999	3.00%
11	10/1998	9/1999	5.00%
12	10/1998	9/1999	4.00%
13	10/1998	9/1999	4.00%
14	10/1998	9/1999	4.00%

15	10/1998	9/1999	4.00%
16	10/1998	6/1999	5.00%
17	5/1999	6/1999	2.00%
18	10/1998	9/1999	30.00%
19	10/1998	9/1999	5.00%
20	8/1999	9/1999	5.00%
			TOTAL 100.00%

Schedule constraints.
There is risk of not completing construction of facilities in an timely fashion. NEPA is proceeding on schedule. There is a risk that too few fish may be available in some years to meet collection goals.

Completion date.
2002

Section 5. Budget

FY99 budget by line item

Item	**Note**	**FY99**
Personnel		$196,930
Fringe benefits		$74,675
Supplies, materials, non-expendable property		$36,530
Operations & maintenance		$60,200
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		$8,835
PIT tags	# of tags: 1700	$4,930
Travel		$29,500
Indirect costs		$91,400
Subcontracts		$ 0
Other		$ 0
TOTAL		$503,000

Outyear costs

Outyear costs	**FY2000**	**FY01**	**FY02**	**FY03**
Total budget	$518,090	$533,633	$549,642	$566,131
O&M as % of total	12.00%	12.00%	12.00%	12.00%

Section 6. Abstract

This program was initiated as a conservation measure in response to severly declining runs of chinook salmon in the Grande Ronde Basin. Our **goal** is to prevent extinction of the three populations and provide a future basis to reverse the decline in stock abundance of Grande Ronde River chinook salmon and ensure a high probability of population persistence well into the future once the causes of basin wide population declines have been addressed. Associated **objectives** include: **1)** to prevent extinction of native wild chinook populations in the Lostine, upper Grande Ronde River and Catherine Creek, **2)** maintain genetic diversity of indigenous artificially propagated chinook populations, **3)** maintain genetic diversity in wild chinook populations and **4)** assess the effectiveness of captive broodstock programs for use in recovery of chinook salmon.l

We have collected naturally-produced juveniles for three years (1995-97), and reared these juveniles to near smolt stage at Lookingglass Fish Hatchery (LGFH). Two-thirds of these smolts will then be transferred to Bonneville Fish Hatchery (BOH) and one-third to NMFS Manchester Marine Lab (MML) respectively. These fish are reared at those facilities to maturity. We plan to continue collecting juveniles on an annual basis. Maturing adults are transported from MML to BOH and all fish spawned at BOH. Captive broodstock progeny will be reared to the smolt stage at Lookingglass Hatchery. We anticipate our first smolt release in 2000 from spawn in 1998. Resulting smolts (150,000 per stock) will be released into the river of parent origin and/or other chinook producing streams within that drainage. One to three years following these releases a minimum of 150 adults should return to the river of parent origin.

Section 7. Project description

a. Technical and/or scientific background.

Present escapement levels and recent trends indicate that Grande Ronde basin spring chinook are in imminent danger of extinction. Progeny-to-parent ratios have been below 1.0% for the past eight completed broodyears. Captive broodstock programs for Snake River spring/summer chinook salmon are supported by recommendations in the Snake River Recovery Team's report (Snake River Salmon Recovery Team Report 1994), NMFS draft recovery plan, and the Northwest Power Planning Council's Fish and Wildlife Program (Northwest Power Planning Council 1994). NMFS draft recovery plan states "captive broodstock and supplementation programs should be initiated and/or continued for populations identified as being at imminent risk of extinction, facing severe inbreeding depression, or facing demographic risks" and further states "considering the critical low abundance of Grande Ronde spring/summer chinook salmon, impacts to listed fish should be avoided and Lookingglass Hatchery should be operated to prevent extinction of local populations. Consequently indigenous broodstock should be immediately transferred to Lookingglass Hatchery (natural fish collected in 1995), and production should be maximized to supplement natural populations." Our goal is to prevent extinction of the three populations and provide a future basis to reverse the decline in stock abundance and ensure a high probability of population persistence. Use of non-local broodstock is inconsistent with sound conservative principles and development of local broodstocks was recommended by an Independent Scientific Review Panel under U.S. vs Oregon Grande Ronde Chinook dispute resolution in 1996. This project is directed by the conceptual framework that identifies maintenance of, within and between population variations in genetic and life history characteristics as essential for long term fitness and persistence.

b. Proposal objectives.

Program success is dependent on finalizing development of propagation facilities at Lookingglass and Bonneville hatcheries as well as achievement of adequate survival, growth, maturation, and gamete viability objectives. Recovery of these populations is dependent on improved juvenile and adult survival through mainstem reservoirs and dams. Detailed assumptions used to develop the production program are described below:

1. We anticipate a 1:1 sex ratio at collection for each population.
2. Recent data suggest that 50% of the parr we collect are likely to survive to spawn (Smith and Wampler, 1995). The 90% survival from parr to smolt at Lookingglass Hatchery during the first year of a program, 80% survival from smolt to three year adult for spring chinook in Washington's dungenness program (Witczak 1995) and 90% first year survival observed for juvenile Redfish Lake sockeye held at Manchester Marine Lab (C. Manhken, NMFS, Seattle, personal communication) suggest it is unlikely we will need to collect more than 500 juveniles. Thus, the model is based on a collection of 500 juveniles each year from 1995-2000.
3. We predict that approximately 6% of the females will mature at age 3, 78% at age 4 and 16% at age 5 (adapted from Nielson and Geen, 1986; Hankin et al., 1993; Burck, 1994; Appleby and Keown, 1995; and ODFW Annual Reports).
4. Based on the information reported in Flagg and Mahnken (1995), we expect fecundities to be approximately 1,200, 3,000, and 4,000 eggs for age 3, age 4, and age 5 females, respectively.
5. This production model assumed a 75% egg viability (see Smith and Wampler, 1995), and 80% viable egg to smolt survival (unpublished data from the program at Lookingglass Hatchery). In our 1995 permit application we use an estimate of 45% egg viability. More recent data suggests that 75% egg viability might be reasonable to expect (Flagg and Mahnken, 1995). Higher than expected egg viability and egg-to-smolt survival may require a reduction in the number of juveniles that are collected in the future.
6. Typically, chinook reared at and released from Lookingglass Hatchery return at a 0.1% smolt-to-adult survival rate (ODFW Annual Reports).
7. Data from previous programs at Lookingglass Hatchery suggests that 10%, 60%, and 30% of the adults will return at ages 3, 4, and 5m, respectively (ODFW Annual Reports).
8. The estimates of maturation rates and survival are based on the history of production at Lookingglass Hatchery and additional studies cited above.
9. Based on recent modeling (updated with experience from the first year's collections as

well as experience from other programs) 500 parr or less would be sufficient to produce the needed smolts. Our goal for 1996 was to collect 500 parr. The number of parr collected should then be reassessed prior to each successive year's collection. If the needed number of parr is reduced, the minimum number collected should be 300. Any less will be difficult to manage as we split the populations between sites and strategies, and potentially could represent a lesser number of parents for the original stock.

Measureable, short-term objectives of this captive broodstock program are:

1) Assess maturation and characterize length, weight, and survival of all three stocks at Manchester Marine Laboratory and at Bonneville Fish Hatchery
2) Monitor the growth, development, and survival of the fish at Lookingglass Fish Hatchery
3) Mark all 1997 individuals in all three stocks with a secondary mark
4) Determine when fish are ready to be transferred to seawater.
5) Collect 1998 brood juveniles from Catherine Creek, Lostine River, and upper Grande Ronde River populations.
6) Provide samples for genetic analysis from 1996 and 1997 mortalities from Catherine Creek, Lostine River, and upper Grande Ronde River populations.
7) Coordinate ESA permit activities and participate in captive broodstock planning and oversight.
8) Develop and implement complex matrix spawning protocols.
9) Develop and maintain a database on the captive fish
10) Insure that an Annual Operations Plan is developed for the Captive Broodstock Program.
11) Analyse and summarize data and prepare and submit an annual report
12) Determine etiology of captive broodstock morbidity and mortality.
13) Implement prophylactic erythromycin treatments for bacterial kidney disease under Investigational New Animal Drug (INAD) protocols.
14) Implement therapeutic treatments as described in the Section 10 permit.
15) Monitor fish culture practices and fish handling for situations that may contribute to impaired fish health or exacerbate disease.
16) Rear 1997 broodyear parr until they reach smoltification at Lookingglass Hatchery.
17) Safely transport 1997 brood fish to BOH and MML following smoltification.
18) Rear all 1994, 1995, 1996, and 1997 fish at Bonneville Fish Hatchery.
19) Oversee and facilitate the spawning of all ripe 1994, 1995, 1996 and 1997 fish.
20) Receive 1998 brood after collection and rearing at Lookingglass Hatchery.

c. Rationale and significance to Regional Programs.

This Captive Broodstock Program is one of the first such production programs in the Columbia Basin and is completely integrated with the LSRCP. Eggs produced from spawned captive brood become the source for smolt production under the Grande Ronde

Basin Chinook LSRCP. Additionally this Captive Broodstock Program is a large scale adaptive management program that is looking at three production strategies: **a)** accelerated presmolt rearing with post-smolt freshwater rearing, **b)** natural presmolt rearing with post-smolt freshwater rearing, and **c)** natural presmolt rearing with post-smolt seawater rearing.

<u>The long-term, progamatic objectives of this Captive Broodstock Program are:</u>

1) Prevent extinction of native wild populations in the Lostine and upper Grande Ronde rivers and Catherine Creek
2) Maintain genetic diversity of indigenous artifically propagated chinook populations.
3) Maintain genetic diversity of wild populations.
4) Develop indigenous broodstocks for Grande Ronde chinook hatchery program.
5) Modify facilities at Bonneville and Lookingglass hatcheries to provide capability to implement captive broodstock programs.
6) Assess captive broodstock program performance in achieving adult broodstock, smolt production, adult return goals, and management.
7) Determine optimum program operational criteria to ensure success of achieving objectives.

Table 1. Relationships of the Captive Broodstock Program to other Bonneville projects.

Project Number	Project title/description	Nature of relationship
9202604	Early life history of spring chinook salmon in the Grande Ronde Basin.	We utilize migration timing information from this project to determine when to collect juveniles for captive broodstock. Life history information will also be used to access the success of supplementation programs
8805301	NE Oregon Hatcheries - ODFW, CTUIR, and NPT	Captive broodstock program will be directly integrated into the NE Oregon Hatcheries program as it will be providing the broodstock and eggs that will be utilized for NEOH.
8905302	NE Oregon Hatcheries - ODFW, CTUIR, and NPT	Captive broodstock program will be directly integrated into the NE Oregon Hatcheries program as it will be providing the broodstock and eggs that will be utilized for NEOH.
5520700	Captive Broodstock Artificial Propagation	This is the NPT funding for cooperative evaluation of the Grande Ronde Spring Chinook Captive Broodstock Program.
8909600	Genetic Monitoring and Evaluation of Snake River Salmon and Steelhead	This project provides samples for the genetics monitoring program.
Not Applicable	Fish Passage Center Smolt Monitoring Program - Migration characteristics	During the summer we PIT tag parr in Catherine Cr & the Lostine and Grande Ronde Rivers. We collect parr for captive broodstock when parr PIT tagging occurs. This project also provides personnel and information to improve efficiencies.

d. Project history

<u>History</u>**:** This captive broodstock program was initiated in the Grande Ronde basin in 1995 when spring chinook juveniles were collected from Catherine Creek, the upper Grande Ronde and Lostine rivers. These fish were reared until the yearling smolt stage and then were transferred to temporary facilities at Bonneville Hatchery and some to the Manchester Marine Laboratory. We completed a comprehensive plan for the captive broodstock program and were issued a NMFS ESA Section 10 permit in 1996. We collected parr from the Lostine River and Catherine Creek in 1996 and 1997. These fish are currently being reared at Lookingglass and Bonneville hatcheries, and Manchester Marine Laboratory. This work was initially funded by the USFWS under LSRCP. It was transfered to the FWP in FY1998 as Project 9801001.

<u>Reports and technical papers</u>**:**

1) Section 10 ESA Application Permit - ODFW 1995

2) Comprehensive Plan for Grande Ronde Basin Spring Chinook Captive Broodstocks Section 10 Application 1996 - ODFW

<u>Major results achieved</u>:

<u>1994 Brood</u>

As of 1 January 1997, 415, 92 and 388 fish from Catherine Creek, the upper Grande Ronde River, and the Lostine River respectively, were alive and rearing at either Bonneville Hatchery or the Manchester Marine Laboratory. As of December 31, 1997 there were 288, 38 and 238 fish remaining alive from Catherine Creek, the upper Grande Ronde River, and the Lostine River stocks respectively. Therefore total mortalities for 1997 were 127, 34, and 151 mortalities from Catherine Creek, the upper Grande Ronde River and the Lostine River respectively. Most mortalities that occurred during 1997 were sent to either the Clackamas, La Grande or Manchester Fish Health Labs. In addition the cause of some mortalities were obvious. From the Catherine Creek stock 88 fish were killed following spawning, 13 jumped out of rearing tanks, and two fish could not be accounted for and were assumed mortalities. Mortalities from the Lostine River stock included 90 fish that were killed following spawning, 13 fish which jumped out of rearing tanks, and three fish that were unaccounted for and assumed mortalities. Mortalities from the upper Grande Ronde River stock included 13 fish that were killed following spawning

No actual spawning occurred with 94 brood salmon because no females matured. Many males did mature and their semen was collected, cryopreserved and stored. Fish were examined for signs of maturity on five occassions at Bonneville Hatchery (July 15-16, August 12, September 16, October 21-22, and November 18) and on two occassions at Manchester Marine Laboratory (July 17 and August 14). Following these maturity sortings the fish were regularly examined for ripeness and spawned. These ripeness sortings/ spawnings took place at Bonneville hatchery on six occassions (September 17-18 & 29-30, October 9-10 & 21-22, and November 5 & 18). No spawning was done at Manchester.

<u>1995 Brood</u>

As of 1 January 1997, 492, and 474 fish from Catherine Creek, and the Lostine River respectively, were alive and rearing at Lookingglass Hatchery. As of 31 December 1997 there were 395 and 424 fish remaining alive from the Catherine Creek and Lostine River stocks respectively. Therefore total mortalities were 97 and 50 mortalities from Catherine Creek and the Lostine River stocks respectively. Most mortalities that occurred during 1997 rearing were sent to either the Clackamas, La Grande or Manchester Fish Health

Labs. The cause of some mortalities were obvious. From the Catherine Creek stock 10 fish died during a salinity tolerance tests and seven fish could not be accounted for during inventory and were assumed mortalities. Mortalities from the Lostine River stock also included 10 fish that died during a salinity tolerance test and one fish that was unaccounted for and therefore an assumed mortality.

Complete inventories were conducted on April 30 and May 1. At that time there were 489 Catherine Creek fish and 470 Lostine River fish. All fish were also given a dorsal sinus injection of erythromycin. In addition, salinity tolerance tests were initiated with test subjects removed from ponds destined for Manchester. By 20 June, all fish destined for rearing at Manchester Marine Lab were transferred; 157 Catherine Creek fish and 152 Lostine River fish. On 18 June, all fish destined for rearing at Bonneville Fish hatchery were transferred; 320 and 311 for Catherine Creek and Lostine River stocks respectively. A total of 885 fish were tagged with Visual Implant (VI) tags during July at Bonneville Hatchery and August at Manchester Marine Lab. At Bonneville, 319 Catherine Creek and 305 Lostine River fish were tagged. At Manchester Marine Lab, 119 Catherine Creek and 142 Lostine River fished were tagged.

1996 Brood

Juvenile salmon were collected using a passive seining technique that combines snorkeling and seining. Using this method, fifteen hundred spring chinook salmon parr were collected for Captive Broodstock during August and September 1997; 499 Catherine Creek, 500 Lostine River and 500 Grande Ronde River stock. We originally collected 500 parr from each stock, but at PIT tagging found that one of the Catherine Creek parr was actually a juvenile steelhead which was subsequently released. Also during PIT tagging we found that we had one “extra” Lostine River chinook parr.

All recovered mortalities, three (3) from the Grande Ronde River and two (2) from Catherine Creek were sent to the LaGrande fish health lab for analysis. No mortalities occurred during collection, transport or PIT tagging. Between collection and 31 December 1997 there were five (5) incidental mortalities and three (3) missing fish which were asssumed to be unaccounted for mortalities. Of the total mortality, three were Catherine Creek, five were Grande Ronde River and none were Lostine River fish.

Adaptive management implications: The Grande Ronde basin once supported large runs of chinook salmon with estimated escapements in excess of 10,000 as recently as the late 1950s. Natural escapement declines in the Grande Ronde basin have paralleled those of other Snake River stocks. Catherine Creek, Grande Ronde, and Lostine rivers were historically three of the most productive populations in the Grande Ronde basin. Escapement levels in thesse three rivers dropped to alarming low levels in 1994 and 1995. We are presently in an emergency situation where dramatic and unprecedented efforts are needed to prevent extinction as well as preserve any future options for use of natural fish for artificial propagation programs. The initial management plan under the LSRCP program called for hatchery supplementation of four chinook populations in the basin: Catherine Creek, Wallowa, Grande Ronde, and Lostine rivers. The Oregon Department of Fish and Wildlife, U. S. Fish and Wildlife Service, and the Nez Perce Tribe decided to immediately begin development of broodstocks from local natural populations for genetic conservation and natural production enhancement. This decision was a result of a number of factors including: increased emphasis on natural production and endemic stock recovery; consultations and requirements resulting from listing of

Grande Ronde chinook populations as endangered; our lack of success in using non-local hatchery stocks for supplementing Grande Ronde chinook populations; and preferred strategies for use of artificial propagation identified in the NMFS draft recovery plan. It is too early in the program to provide significant results, however we believe that this program will provide substantial new knowledge for the use of artificial propagation to enhance natural production.

Years underway: Two and one-half (2-1/2) years.

Past costs: **FY96** = $117,000; **FY97** = 338,700 and **FY98** = 418,400. (**NOTE:** FY96 and FY97 funds were from the USFWS; FY98 funds are from Bonneville).

e. Methods.

In an effort to reduce the probability of extinction and preserve the genetic resources contained in these populations, we believe it prudent to continue captive broodstock programs for the Lostine River, Catherine Creek, and upper Grande Ronde River populations and to initiate more conventional adult collection when returns warrant it. These programs, if successful, will provide returning adults to maintain hatchery broodstock conservation programs and to release adults and juveniles into the stream of parent origin and/or other appropriate locations.

We plan to collect naturally-produced juveniles for a minimum of five years (longer if the program demonstrates success), rear the juveniles to near smolt stage at Lookingglass Fish Hatchery (LGFH), transport two-thirds as smolts to Bonneville Fish Hatchery (BOH) and one-third as smolts to NMFS Manchester Marine Lab (MML), respectively, rear fish at those facilities to maturity. Maturing adults will be transported from MML to BOH and all fish spawned at BOH. Captive broodstock progeny will be incubated to eyed stage at BOH then transported to LGFH for final incubation and rearing to the smolt stage. Resulting smolts will be released into the river of parent origin and/or other chinook producing streams within that drainage. Other potential program strategies include outplanting of adults and/or progeny as eggs and/or parr produced in excess of smolt needs directly into unseeded historic production areas.

These programs will be operated under the adaptive management philosophy and will rely extensively on monitoring and evaluation results and new knowledge for making future decisions and adapting program approaches.

Evaluation plan

There are numerous uncertainties associated with salmonid captive broodstock programs (Flagg and Mahnken, 1995). There is a need to evaluate experimentally various aspects of rearing and spawning captive salmonids. However, each evaluation has varying degrees of risk to or impact on the population associated with an experiment. Since we are working with endangered stocks of spring chinook salmon, we need to balance information needs with risks to the captive populations. Thus, we are proposing to evaluate aspects of captive rearing and breeding that address relatively important uncertainties but will have minimal impact to the groups of fish being studied.

The first evaluation we propose is a comparison of fish reared exclusively in fresh water to those reared in fresh water as juveniles, sea water as adults, and returned to fresh water for final maturation. Fish in the first evaluation will be reared under simulated natural growth rates. The second evaluation we propose is a comparison of fish that, as juveniles, are grown at either a natural rate or an accelerated rate. Growth rates will be manipulated using water temperature and feeding levels. Fish growing at a natural rate will be reared in water temperatures (5-14°C) that simulate the natural water temperature cycle. Fish growing at an accelerated rate will be reared in constant 14°C water. Feeding will be adjusted according to water temperature. Fish in the second evaluation will be reared exclusively in fresh water. In each evaluation, we will compare the overall performance of captive fish and their progeny.

<u>Overview</u>

Specific evaluations will not be conducted with the 1994 brood of captive fish. Rather, these fish will be monitored during the course of their development in an effort to fine tune future evaluations. Beginning with the 1995 brood of captive fish, the two evaluations that we are proposing can be accomplished by dividing each stock of captive fish into three groups (by broodyear). Thus, for any given brood we will have a total of nine groups of fish (see table). Approximately two-thirds of the fish will be reared in fresh water while the other third will be reared in sea water. The freshwater, natural growth group of each stock will serve as a control for both the other treatments. Variables other than environmental salinity, juvenile growth rate, and perhaps adult diet will remain as similar between treatments as possible. For example, at all times, all fish will be reared under a simulated natural photoperiod. Treatment groups will always be kept separate and brood years will be kept separate until spawning. Fish from different broodyears but within a treatment group may be spawned together. After spawning, F1-generation fish resulting from parents of a certain treatment group will be kept separate from F1-generation fish resulting from parents of a different treatment group. This separation will remain until F1-generation smolts are transported to acclimation facilities. Captive fish will be reared through maturation, spawned, and then their progeny reared through the yearling smolt stage. This entire cycle should take between 3.5 and 5.5 years. For example, fish collected in September of 1995 would spawn at age 5 in September of 1999 and the resulting progeny would be released as smolts in the spring of 2001. For the purpose of clarifying the terminology associated with the monitoring and evaluation plan, we have divided this cycle into four periods (see table). The <u>Captive Juvenile</u> period begins at collection and ends once fish have been transferred to BOH or MML. The captive juvenile period is composed of two shorter periods; <u>pre-smolt growth</u> and <u>smoltification</u>. The <u>Captive Adult</u> period begins once fish have been transferred to BOH or the MML and ends once fish have been spawned or die. The captive adult period is composed of three shorter periods; <u>post-smolt growth</u>, <u>maturation</u>, and <u>spawning</u>.

Table 2. Approximate number and rearing location for captive brood post-smolts. (**BOH** = Bonneville Fish Hatchery; **MML** = Manchester Marine Lab).

Treatment	Stock		
	Lostine River	Catherine Creek	Grande Ronde River
Freshwater,			
fast growth	n=166 @BOH	n=166 @BOH	n=166 @BOH
natural growth	n=166 @BOH	n=166 @BOH	n=166 @BOH
Seawater,			
natural growth	n=166 @MML	n=166 @MML	n=166 @MML

The F1-Generation period begins once embryos from captive fish are formed and ends when fish from these embryos die. The F1-generation period is composed of four shorter periods; incubation, juvenile rearing, smolt release, and maturation. The F2-Generation period begins once embryos from F1-Generation fish are formed and ends when fish from these embryos die. The F2-Generation period is composed of three shorter periods; pre-smolt, smolt, and post-smolt.

Table 3. Captive broodstock, monitoring and evaluation terminology.

Period	Example of approximate actual time period for fish maturing at age four
Captive Juvenile	Sep 95 - Jun 96
pre-smolt growth	Sep 95 - Apr 96
smoltification	Apr 96 - Jun 96
Captive Adult	Jun 96 - Sep 98
post-smolt growth	Jul 96 - Jun 98
maturation	Jun 98 - Sep 98
spawning	Sep 98
F1-Generation	Sep 98 - Sep 02
incubation	Sep 98 - Feb 99
juvenile rearing	Feb 99 - Apr 00
smolt release	Apr 00
adult return	Jun 02 - Sep 02
F2-Generation	Sep 02 - Sep 07
pre-smolt	Sep 02 - Mar 04
smolt	Apr 04 - Jun 04
post-smolt	Jul 04 - Sep 07

Design

Each captive brood cycle will begin when natural fish are collected from the field, approximately 12 months after eggs were fertilized . Approximately one month after collection (13 months after fertilization) each fish will be tagged with a Passive Integrated Transponder (PIT) (Prentice et al. 1986, 1990). Fish will be taken from the troughs and anesthetized using 40-50 ppm MS-222. PIT-tagging will be conducted in accordance with the PIT Tag Marking Manual (PIT Tag Steering Committee, 1993). We will inject PIT tags manually using modified hypodermic syringes. Syringes and needles will be disinfected for 10 minutes in 70% ethanol prior to tagging. Fish will be allowed to recover in fresh water before being returned to their rearing facilities. PIT tags will allow us to identify individual fish during rearing and spawning. Losses associated with the BY94, captive broodstock tagging operation included only 3 of 1,040 tagged fish.

To minimize stress around the smolt period, handling of the fish will be minimized during April, May, and June (19, 20 and 21 months after fertilization). The exceptions to this are that, near the peak of smoltification fish will be hauled to either MML or BOH. Fish will receive food during these three months, mortalities will be removed from the rearing tanks, pathological treatments may be applied, and these tanks may need to be cleaned periodically.

Fish will be transferred to MML for seawater rearing, on or about June 1, 1996. The specific time of this transfer will be decided based on information from the literature, the time at which naturally-migrating Grande Ronde River fish reach Lower Granite Dam and anticipated time they would reach the estuary, the results of similar seawater transfers conducted by the Idaho Department of Fish and Game in the spring of 1996, and the performance of captive broodstock fish (BY94) in salinity tolerance tests,. In future years (BY 95 and later), we propose to rear approximately 250 conventional hatchery fish (i.e. Rapid River stock) in conditions that mimic those of the captive brood fish. To time transfers into seawater, we will use these fish as surrogates in salinity tolerance tests. When surrogate fish reach 100% survival in a salinity tolerance test, captive brood fish will be transferred to adult rearing facilities.

After fish are transported to the MML, they will be placed into approximately 0.9 x 1.5 m circular tanks along with the water from the transportation vehicle. This water (0 ppt salinity) will be aerated to maintain d.o. levels of at least 9 ppm. Salinities will be increased gradually so that the fish may acclimate to full strength salinity. Final conditions will be 26-29 ppt salinity, ≥ 98% oxygen saturation, and densities ≤ 24.3 kg/m^3.

Fish to be reared at BOH will be transported in association with the inventory in March, as yearlings (excepting BY94). Once at BOH fish will be placed into approximately 0.9 x 1.5 m circular tanks filled with well water (0 ppt salinity, ≥ 98% oxygen saturation, and ≤ 24.3 kg/m^3), also at temperatures similar to those at LGFH and to those in the transportation vehicle. With the exception of a freshwater environment, these fish will be reared under conditions as similar as possible to those experienced by fish at MML (i.e.

tank size, tank type, loading factors, feeding schedules, etc.).

One exception to the requirement of similar rearing conditions between BOH and MML may be the diet of the fish. Fish at MML and at BOH will be fed diets that are formulated to promote maximum survival and adequate growth. Dietary formulas will be developed from information in the literature and from ongoing projects (including those around the Great Lakes where natural chinook spend their entire life cycle in fresh water). Fish reared and maturing in fresh and sea water may respond to diets differently and have different nutritional requirements. Thus, diets of captive fish reared in seawater may need to be different than diets of fish reared in freshwater.
Post-smolt rearing will consist of a period of growth and maturation. During this rearing visual implant (VI) tags will be inserted into each fish when the population reaches a mean of approximately 250 mm in fork length. This should occur approximately 24-26 months post-fertilization. Due to the potential for PIT tag loss and difficulty reading PIT tags as fish mature, a VI tag will also be applied to insure identification of individual fish. Then fish will be allowed to recover in fresh water before being returned to their rearing facilities. The combination of PIT and VI tags should allow us to identify individual fish during rearing and spawning operations. Otherwise, we will attempt to minimize disturbances to the fish during post-smolt growth. The exceptions will be during visual monitoring, feeding, the removal of mortalities, cleaning of troughs, and pathological protocols.

Maturation of fish will be judged by gross morphological characteristics (i.e. coloration). Once near mid-July and once near mid-August, maturing fish will be separated from immature fish. Fish from MML will be transported to BOH. At BOH mature fish from MML and BOH will be held in Tanner Creek water so they can experience water temperature fluctuations and held under a simulated natural photoperiod to help synchronize their maturation. We anticipate that peak maturation will be during the months of August and September. When fish become ripe they will be spawned, at BOH according to the general procedures used at LGFH for Imnaha stock chinook. This includes stripping the eggs into a colander to remove ovarian fluid and water-hardening in 75 ppm Argentyne. After fertilization, F1-generation embryos from a given female will be trayed together and kept separate from embryos from other females. Eyed eggs will be transported to LGFH for completion of incubation. Embryos will be kept distinguishable by female until fry hatch and are placed in Canadian troughs, sometime around February.

F1-generation fry will be reared in Canadian troughs following standard protocols for LGFH. They will be moved into nine outdoor ponds around April. This will allow us to keep progeny from different treatments separate. They will be fin-marked and coded-wire-tagged during June and July. Progeny from each treatment group will be tagged to permit later identification. After tagging they will be placed back into their original nine ponds. At full program, approximately 50,000 fish will be reared in each pond. Fish will be reared and sampled according to standard protocols at LGFH and targeted for 44 fish/kg, or a mean fork length of 125 mm, at their release as yearling smolts. Near the ensuing February, a minimum of 500 fish from each pond will be PIT-tagged.

In March, fish will be hauled to acclimation facilities located within the area of their natal stream where natural fish spawn. A proportionate number of fish from each evaluation group within a given stock will be mixed together at the time of transportation. A minimum of two acclimation sites will be distributed along this area so that releases will be scattered spatially. Acclimation sites will be supplied with ambient stream water and fish at these sites given supplemental feed. In April, after a 20-30 day period of acclimation, fish will be released into the stream.

We anticipate that some of these fish will mature two, three, or four summers after they are released. Some of these fish may be captured in fisheries while others will return to the Grande Ronde River basin. Weirs will be placed near the mouth of the Lostine River, on Catherine Creek near the town of Union, and on the upper Grande Ronde River upstream of the town of La Grande. Of those adults returning, some will be allowed to spawn naturally and some may be collected at weirs for use as spawners in unseeded habitat. Adult returns from the captive broodstock program will not be incorporated into any conventional adult collection supplementation program.

F1-Generation fish that are allowed to spawn naturally may reproduce with other natural fish or other F1-Generation fish. The majority of the successful progeny produced from these matings are expected to migrate to the ocean as yearlings and return when they are 3, 4, and 5 years old. We will monitor the production and life-history characteristics of the F2-Generation fish. Standard sampling will be conducted on pre-smolts to determine their relative abundance and to collect morphometric data and tissue for subsequent genetic analysis. Some fish may also be tagged so their migratory behavior can be evaluated. Juvenile migrant traps and weirs will be placed in the Lostine and upper Grande Ronde rivers as well as Catherine Creek. The production and timing of fish migrating to and from the ocean will be monitored. Characteristics of each study population will be evaluated prior to, during, and (potentially) after the captive broodstock program.

At all times, great care will be taken to minimize stress and any adverse impacts that monitoring may have on the fish. When possible, all variables will be associated with the tag code of an individual fish. The monitoring aspect of this program is designed to allow us the ability to make comparisons in our experimental evaluations, to monitor the basic progress of the fish, to detect areas of concern that may need our immediate attention, and to judge the adequacy of the benchmarks we have used to design the overall captive broodstock program (for example: a 75% egg viability of the captive brood adults). In general, along with the pathological sampling, we will record the length, weight, maturity, and gonadal status of all mortalities.

Fish Health Monitoring

There are no reliable non-lethal or non-invasive sampling techniques for infectious diseases that could potentially occur in the spring/summer chinook maintained in the

captive broodstock program. Among the infectious diseases that could occur are: bacterial kidney disease (BKD), erythrocytic inclusion body syndrome (EIBS), bacterial cold water disease (CWD), enteric redmouth disease (ERM), bacterial gill disease (BGD), furunculosis, columnaris and infectious hematopoietic necrosis (IHN). External fungus on the body or gills is always a threat and infestations by ectoparasites are possible. The two most survival-threatening infections are judged to be BKD and external fungus.
Because there are no reliable non-lethal or non-invasive sampling techniques for any of the agents causing the infections or infestations listed above, monitoring of morbidity and mortality is critical. This will provide the primary basis for the need for antibiotic or chemical treatments for diseases for which these therapies are appropriate. Daily observations of the fish by hatchery personnel and periodic inspections by fish pathology personnel may also help to identify conditions requiring treatment before clinical disease occurs. While there are capabilities for invasive sampling for some disease agents, these pose a greater risk and stress than can be justified for routine monitoring purposes.

f. Facilities and equipment.

Lookingglass Hatchery

- All permanent facilities, utilities and maintenance at Lookingglass Hatchery
- Twelve (12) Canadian troughs for juvenile rearing
- Three (3) chillers for water temperature control
- One (1) PIT tag station with associated computer and software
- Water temperature monitoring system including an integrated S.C.A.D.A. system
- Laboratory facilities
- Pathogen-free water supply
- One (1) diesel powered emergency electrical backup system
- One (1) vacuum system for cleaning captive brood troughs

Bonneville Hatchery

- One (1) 10,449 ft^2 captive broodstock building with office, storage, rearing and spawning facilities
- Fifteen (15) 20 foot diameter rearing tanks
- Four (4) 10 foot diameter rearing tanks
- UV water purification system
- Well water at 50^o to 54^o
- Equipment and storage facilities for cryopreserved sperm
- ...Vehicles and containers for transporting water-hardened eggs to Irrigon Hatchery

Fish Transport

- Extra large (40 gal) coolers for transporting collected parr
- One (1) Pickup truck with a 200 gal. slip-in portable transport tank
- One(1) 400 gal portable transport tank mounted on a trailer
- One (1) 2,800 gallon fish liberation truck

- All other transport-related supplies, equipment and the associated equipment maintenance for safely moving fish

Fish Research

- Desk top and laptop computers and associated software for program tracking and report preparation.
- Underwater camera and combination VCR/TV for salmonid morphology monitoring
- Electronic scales, PIT tag detectors, oxygen and temperature monitoring equipment
- One (1) suburban for transport of personnel and equipment
- One (1) cargo trailer for transporting equipment to various collection and monitoring locations

g. References.

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Burck, W. 1994. Life history of spring chinook salmon in Lookingglass Creek, Oregon. Information Report, Oregon Department of Fish and Wildlife, Report No. 94-1, Portland.

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ODFW (Oregon Department of Fish and Wildlife). 1996. Application For A Permit For Scientific Purposes And To Enhance The Propagation Or Survival Of Endangered Grande Ronde River Basin Spring Chinook Salmon *Oncorhynchus tshawytscha* Under The Endangered Species Act.

Smith, C.J. and P. Wampler. 1995. Dungeness River chinook salmon rebuilding project progress report 1992-1993. Northwest Fishery Resource Bulletin, Project report series No. 3, Washington Department of Fish and Wildlife, Olympia.

SRSRT (Snake River Salmon Recovery Team). 1994. Final recommendations to the National Marine Fisheries Service, Portland, Oregon.

Witczak, Daniel. 1995. Dungeness chinook restoration project - data accumulation 1993 - 1995. Washington Department of Fish and Wildlife.

Section 8. Relationships to other projects

1) Bonneville Hatchery Operations - (NMFS funding): The captive broodstock production facility will be completed at Bonneville Hatchery in May 1998. Management personnel at Bonneville will be overseeing the production program and we will be sharing equipment and personnel with Bonneville Hatchery. All opportunities to maximize efficiency will be sought.

2) LSRCP Hatchery Operations and Evaluations: This captive broodstock program is completely integrated with the LSRCP Program. LSRCP facilities and personnel are implementing the production, evaluations, and fish health monitoring for the captive brood program. Extensive sharing is occurring between the programs. In addition, ongoing research under LSRCP will be providing information to assess the succcess of the Captive Broodstock Program.

3) The Northwest Power Planning Council's Fish and Wildlife Program (NPPC 1994) calls for initiation of captive broodstocks and associated research, Measure 7.4.D.2 requests the Bonneville Power Administration to "fund captive brood stock demonstration projects identified under the coordinated habitat and production process."

4) Captive broodstock and supplementation programs for Snake River spring/summer chinook salmon: These programs are supported by Snake River Recovery Team recommendations (SRSRT, 1994) and NMFS (1995a) draft recovery plan. NMFS draft recovery plan states "captive broodstock and supplementation programs should be initiated and/or continued for populations identified as being at imminent risk of extinction, facing severe inbreeding depression, or facing demographic risks" and further states "considering the critical low abundance of Grande Ronde spring/summer chinook salmon, impacts to listed fish should be avoided and Lookingglass Hatchery should be operated to prevent extinction of local populations. Consequently indigenous broodstock should be immediately transferred to Lookingglass Hatchery (natural fish collected in 1995), and production should be maximized to supplement natural populations."

Section 9. Key personnel

Richard W. Carmichael, Program Leader, 0.1 FTE

Education

B.S., Fisheries Science, Oregon State University, 1979
M.S., Fisheries Science, Oregon State University, 1984

Current employment

Oregon Dept. Fish and Wildlife, Fish Research and Development, La Grande, OR. July 1990 - present. Program Leader - Executive Manager for NE Oregon Scientific Investigations Program. Primary responsibilities are to develop and direct implementation of a complex research program to evaluate success of protecting, reestablishing, and restoring ESA listed and non-listed stocks in eastern Oregon, oversee the work of 14 full-time fisheries biologists and up to 8 projects, and represent ODFW on regional and national scientific committees.

Past employment

Fisheries Research Biologist (Project Leader), Oregon Department of Fish and Wildlife, LaGrande, OR. December 1983 to July 1990.

Fisheries Research Biologist (Assistant Project Leader), Oregon Department of Fish and Wildlife, LaGrande, OR. March 1983 to December 1983.

Project Assistant (Experimental Biology Aid), Oregon Department of Fish and Wildlife, LaGrande, OR. Oct. 1982 to March 1983.

Expertise

Expertise in fisheries research project development and implementation, personnel management, budget development and tracking, technical report writing, natural production and supplementation research, hatchery effectiveness, hatchery and wild fish interactions, life history, harvest assessment, stock assessment, passage evaluation, straying, captive broodstock, statistical analysis, coded-wire tag implementation and assessment, bass and trout ecology, creel censusing.

Recent publications

1997. Straying of Umatilla River hatchery origin fall chinook salmon into the Snake River. (R. W. Carmichael). *In* Genetic effects of straying of non-native hatchery fish into natural populations (R. S. Waples, convenor). National Oceanic and Atmospheric Administration, Seattle, WA.

1995. Status of supplementing chinook salmon natural production in the Imnaha River basin. *In* Uses and effects of cultured fishes in aquatic ecosystems (H.L. Shramm, Jr., and R.G. Piper, eds.)

1994. A comparison of the performance of acclimated and direct stream released , hatchery-reared steelhead smolts in Northeast Oregon. (Whitesel, T.A., P.T. Lofy, R.W. Carmichael, R.T. Messmer, M.W. Flesher, and D.W. Rondorf) Pages 87-92 *in* High performance fish (D.D. MacKinlay, ed.); Fish Physiology Section, American Fisheries Society, Fish Physiology Association, Vancouver, British Columbia, Canada.

Timothy A. Whitesel, Project Leader, 0.2 FTE

Education

1990 - Ph.D., Biological Sciences, University of Rhode Island
1987 - M.S., Zoology, University of Rhode Island.
1985 - B.A., Philosophy, State University of New York, College at Fredonia
1983 - B.S., Biology, State University of New York, College at Fredonia

Recent Professional Experience

July 1991 - present. **Fisheries Research Biologist** working for the Oregon Dept. Fish and Wildlife, Fish Research and Development, La Grande, OR.
January - July 1991. **Postdoctoral Research Associate**, under the guidance of Dr. Kenneth Able, Center for Coastal and Environmental Studies, Rutgers University.
September - December 1990. **Postdoctoral research Fellow**, under the guidance of Dr. Howard E. Winn, Graduate School of Oceanography, University of Rhode Island.

Recent Teaching Experience

March, 1995 - present. **Adjunct Professor**, Biology Program, Eastern Oregon University, La Grande.
October, 1993 - March, 1994. **Tutor**, Eastern Oregon State College, La Grande
June - August, 1992 and June - August 1994. **Mentor**, Oregon Department of Fish and Wildlife, La Grande, OR.
February - June 1991. **Adjunct Professor**, Biology Program, Stockton State College of New Jersey, Pomona.

Professional Affiliations
American Fisheries Society
Sigma Xi

Selected publications

In Press. **Accuracy of fork length estimates for Chinook salmon and Steelhead in Compartmentalized and Standaard Hatchery Raceways.** Prog. Fish-Culturist. (M. Hayes, R.W. Carmichael, M. Keefe, T.A. Whitesel)

1992. **Plasma thyroid hormone levels in migratory and lake-resident coho salmon juveniles from the Karluk River system, Alaska.** Trans. Amer. Fish. Soc. 121:199-205. (T.A. Whitesel)

Section 10. Information/technology transfer

Research reviews
Reports - monthly, quarterly, annual
ESA annual reports
ESA permits
Technical manuscripts
Technical presentations
Hatchery effectiveness workshops
Public presentations (schools, sportsman and civic groups).

There are multiple decision levels that the information will be used at. At the field biologist level information will be transferred and used by regular communication and contact. At the agency level information will be input into the formal decision process by written communication. Information will be input into the NMFS recovery plan process through written communication and into the CBFWA process by verbal and written communication. The format of feedback will be description of results, recommendations, and formal publication. We have established multiagency management oversight teams for decision making.